


Article

Evaluation of the Performance of Helmet Prototypes Fabricated from Acrylonitrile Butadiene Styrene Composites Filled with Natural Resource

Siti Nikmatin ^{1,*}, Bambang Hermawan ¹, Irmansyah Irmansyah ¹, Mohammad Nur Indro ¹, Ahmad Beng Hong Kueh ^{2,3} and Achmad Syafiuddin ⁴ 

¹ Department of Physics, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, 16680 Bogor, Indonesia; bhermawan1000@gmail.com (B.H.); irmansyah@ipb.ac.id (I.I.); mnindro@gmail.com (M.N.I.)

² Construction Research Centre (CRC), Institute for Smart Infrastructure and Innovative Construction (ISIIC), Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia; kbhahmad@utm.my

³ Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

⁴ Department of Water and Environmental Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia; udenfisika@gmail.com

* Correspondence: snikmatin@apps.ipb.ac.id

Received: 20 November 2018; Accepted: 20 December 2018; Published: 22 December 2018



Abstract: The performance of helmet prototypes fabricated from acrylonitrile butadiene styrene composites filled with oil palm empty fruit bunch fibers was evaluated. The fibers were produced using a milling procedure, while the composites were fabricated using a single-screw extrusion. The physical characteristics of the produced fibers, which are water content, size, and density, were investigated. In addition, the mechanical properties of the produced helmets, including shock absorption, yield stress, frequency, and head injury criterion (HIC), were examined. The impact strength of the produced helmets increases with the rise of filler content. In addition, the helmets were also able to withstand a considerable pressure such that the transmitted pressure was far under the maximum value acceptable by the human skull. The present work also found that HICs exhibited by the investigated helmet prototypes fulfill all the practical guidelines as permitted by the Indonesian government. In terms of novelty, such innovation can be considered the first invention in Indonesia since the endorsement of the use of motorcycle helmets.

Keywords: oil palm; acrylonitrile butadiene styrene; natural fillers; mechanical properties

1. Introduction

Helmets have been widely worn as a form of protective headgear, with the primary goal of reducing the risk of injury caused by impact incidents [1–6]. Although the development of helmets is well-established, there is a motivated necessity for fabricating helmet shells that meet certain stringent safety requirements, especially with respect to improving their energy absorption. In particular, the capability of motorcycle safety helmets to absorb the impact energy is one of the critical factors for consideration to reduce severe injury. A well-performing helmet must concurrently protect the human skull and brain, since impact damage induced during a motorcycle accident can cause death. Realizing the life-threatening risk of such an event, the understanding of skull fractures and brain damage inflicted during accidents, including their protection measure, have been of utmost priority to fabricators.